

THE COMPOSITION OF MIXED SPECIES FLOCKS IN LOWLAND AND SUB-MONTANE FORESTS OF MALAYA¹

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OBSERVATION that a quiet tropical forest will suddenly teem with a mass of busy noisy birds only to resume its quiet when they have gone on has been commented upon by many observers who have experienced this phenomenon. Winterbottom (1943, 1949) reported on such flocks in Northern Rhodesia, Stanford (1940) discusses those in Burma, Davis (1946) made a detailed study of Brazilian mixed species flocks, Short (1961) discussed those of Oaxaca, Mexico, and Moynihan (1962) discussed at length such flocks in Panama. Each author in turn reviewed previous or contemporary publications. Systems of classification have been set up for categorizing the species habituating such flocks and theories have been presented concerning the evolution of this flocking behavior, the benefit to the species involved, and the social organization within them.

This is a report of observations of mixed species flocks in western Malaya.

LOCALE

Bird parties or waves were under observation in the tropical rain forest in the vicinity of Kuala Lumpur, Malaysia between January 1959 and June 1963. The bulk of the studies were made in dipterocarp forests of the Gombak watershed east of the city at Mile 13 and Mile 22. A few waves were noted in a secondary lowland forest at the Subang Reserve 15 miles northwest of Kuala Lumpur.

The Mile 13 study area was in selectively cut (many dipterocarps removed) forest along 2½ miles of a logging road from an altitude of 500 to 1000 feet (Fig. 1). About one-half of this distance was along the Gombak River tributaries and the remainder on the hillsides above the streams. The forest was typical of the low uplands with a complex of nearly 200 species of trees per acre. Dipterocarps, including over a hundred species of *Shorea*, *Hopea*, *Dipterocarpus*, *Anisoptera*, *Vatica*, *Cotylelobium*, *Parashorea*, *Pentacme*, *Balanocarpus*, and *Dryobalanops*, dominated the association with overtopping *Shorea*, *Anisoptera*, and *Dipterocarpus* on the ridges. It is a three-storied forest with four stories evident in many places. More than two hundred species of birds inhabited the area.

The Mile 22 study area was at the Genting Sempah Jungle Reserve just below the divide of the central range (Fig. 2). It was at an elevation of

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FIG. 1. The sub-montane forest at Gombak, Mile 13, Altitude 800 feet, after the primary dipterocarps had been removed.



FIG. 2. Primary sub-montane dipterocarp forest at 2,000 feet, Mile 22 Gombak.

2000 feet and in primary hill dipterocarp forest dominated by 50 species of *Shorea*, *Hopea*, *Dipterocarpus*, *Anisoptera*, *Vatica*, and *Balanocarpus*. As in the lower area there were as many as two hundred species of trees to the acre. This is a three- or four-storied forest with *Shorea* and *Anisoptera* giants up to 200 feet high overtopping the lower crowns. The avifauna was as diverse as on the lower slopes.

The third study area at Subang was in 30-year-old secondary forest at an altitude of 150 feet (Fig. 3). It is partially swampy and dominated by young 50- to 80-foot *Shorea*, *Palaquium*, *Dyera*, and *Endospermum*. The avifauna included more than 100 species.

METHODS

Once each week between 1 January 1959 and 1 December 1960 from 0700 to 1200 hours the birds recognizable by call or by sight were tallied along the 2½ mile route (Mile 13) through the forest. The tallies were made while walking at a speed of about one mile per hour (round trip 5 miles). No effort was made to distinguish birds that were counted twice. When a feeding flock was encountered an attempt was made to count and identify as many individuals as possible.

At Mile 22 a platform was built in a giant *Anisoptera laevis* in the first



FIG. 3. Secondary swamp forest at Subang. Lower story dominated by Bertam palms.

crotch of limbs 140 feet above the ground. The entire crown of the tree was above the platform and extended above the surrounding canopy except for trees of equal height at its level and for the canopy extending over the hillside above it. In this location the observer was "captive" while each wave of birds passed around and beneath him. At Mile 13 the observer passed through the wave and beneath it. The difference in viewpoint contributed to the differences in the resulting tallies. Observations from the platform were made once each week from 0600 to 1200 between September 1960 and June 1963.

At Subang the observation route extended through the forest for half a mile and tallies were made along it between 0800 and 0900 twice each week from January to December 1962.

FLOCK COMPOSITION IN THE GOMBAK WATERSHED

During the five-year period of July 1958–July 1963, 197 observations were made in the Gombak watershed, totaling nearly 1000 hours, and in that time 154 mixed species feeding flocks or bird waves were intercepted and tallied. Nearly 6000 birds and a total of 102 species were noted in association in these flocks. In most habitats of the tropical rain forest species are numerous and populations sparse. This was true of the mixed flocks in

TABLE 1
THE COMPOSITION OF BIRD WAVES IN THE GOMBAK WATERSHED

Family	No. of Waves		No. of Birds		Ave. Birds Per Wave		No. of Species	
	M 13	M 22	M 13	M 22	M 13	M 22	M 13	M 22
Columbidae	—	2	—	4	—	2.0	—	1
Psittacidae	3	3	18	4	6.0	1.3	1	1
Cuculidae	28	20	53	26	1.9	1.3	8	5
Trogonidae	1	—	1	—	1.0	—	1	—
Meropidae	3	1	7	1	2.3	1.0	1	1
Capitonidae	3	24	3	140	1.0	5.8	3	5
Picidae	17	21	31	35	1.8	1.7	8	4
Eurylaimidae	3	—	10	—	3.3	—	3	—
Laniidae	6	4	12	26	2.0	6.5	2	1
Oriolidae	27	3	48	3	1.8	1.0	1	1
Dicruridae	35	7	67	10	1.9	1.4	2	1
Campephagidae	53	75	333	559	6.3	7.4	6	4
Pycnonotidae	38	34	144	274	3.8	8.1	14	9
Aegithinidae	66	77	404	848	6.1	11.0	5	6
Timaliidae	40	46	335	247	8.4	5.4	7	8
Muscicapidae	40	57	92	192	2.3	3.4	10	7
Sylviidae	34	60	160	367	4.7	6.1	4	3
Turdidae	—	2	—	2	—	1.0	—	1
Paridae	5	1	7	2	1.4	2.0	1	1
Sittidae	8	31	14	53	1.7	1.7	1	1
Zosteropidae	2	7	25	54	12.5	8.0	1	1
Dicaeidae	11	5	34	9	3.0	1.8	3	4
Nectariniidae	19	20	48	32	2.5	1.6	6	9
Ploceidae	1	—	2	—	2.0	—	1	—
Totals	74	80	2,983	2,911	34.0	32.7	89	75

the Gombak Valley; probably more than 102 species were associated in them during a year's time, but the average number of birds counted per species was only three per flock.

During the day as a wave moves through the forest it encounters many sedentary species, many that are involved in other flock activities and many that are traveling in directions divergent to that of the wave. In most instances during such encounters the extraneous species appear to join the flock in searching for food. During these brief activities all of the species are in mutual competition for food or derive mutual benefits from the search for it. The 102 species which were observed to mingle in the Gombak watershed are listed in the appendix. Table 1 summarizes this long list by families.

In the following discussions it has been necessary to treat the observations

TABLE 2
SUMMARY OF THE MONTHLY OBSERVATIONS OF MIXED SPECIES FLOCKS IN THE COMBAK WATERSHED

	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
No. days of observation	M13 8 M22 14	7 12	6 8	6 5	6 3	5 10	4 13	5 9	4 11	9 12	7 13	7 13	74 123
No. flocks	M13 5 M22 2	1 4	1 3	1 4	3 1	6 9	6 14	4 10	11 12	19 8	10 9	7 4	74 80
No. species	M13 20 M22 7	5 17	8 15	5 21	11 5	17 30	34 36	18 36	29 37	50 20	35 23	22 22	88 75
No. species per flock	M13 8.5 M22 6.5	5.0 6.7	8.0 9.2	5.0 4.2	5.0 5.0	4.7 10.6	10.8 10.7	8.3 12.4	6.5 13.5	11.0 6.8	8.2 7.9	7.8 14.1	7.6 9.8
Total birds	M13 223 M22 33	32 109	15 76	17 95	56 12	192 358	300 564	132 448	390 485	1,111 311	309 221	206 199	2,983 2,911
No. birds per flock	M13 42.6 M22 16.5	32.0 27.2	15.0 25.5	17.0 23.8	19.0 12.0	26.5 39.0	50.0 40.1	37.0 44.4	35.4 50.7	54.3 37.3	30.9 39.3	28.0 37.2	34.2 32.7
No. birds per species	M13 3.2 M22 2.5	4.4 2.5	1.6 2.7	1.4 2.8	2.4 2.4	2.5 3.3	3.0 3.4	3.1 3.2	2.5 3.9	3.1 4.2	2.3 3.6	1.9 3.3	2.7 3.3

TABLE 3
COMMON SPECIES IN WAVES IN THE GOMBAK WATERSHED AS
NOTED AT MILE 13 AND MILE 22

Species	Times observed		Total	Rank
	Mile 13	Mile 22		
Yellow-headed Green Leafbird	52	52	104	1
Green Iora	15	56	71	2
Scarlet Minivet	14	54	68	3
Arctic Leaf Warbler	26	39	65	4
Fiery Minivet	31	32	63	5
Common Nun Babbler	30	31	61	6
Bar-winged Flycatcher-shrike	16	43	59	7
Flyeater	7	47	54	8
Spotted Fantail Flycatcher	9	38	47	9
Fairy Bluebird	19	28	47	10
Lesser Green Leafbird	11	31	42	11
Velvet-fronted Nuthatch	8	31	39	12
Grey-headed Flycatcher	13	22	35	13
Greater Green Leafbird	5	28	33	14
Paradise Flycatcher	21	11	32	15
Verditer Flycatcher	5	26	31	16
Racquet-tailed Drongo	29	0	29	17
Black-headed Oriole	27	2	29	18
Chestnut-breasted Malcoha	16	9	25	19
Scaly-breasted Bulbul	0	22	22	20
Striped Tit Babbler	3	17	20	21
Chestnut-back Scimitar Babbler	5	15	20	22
White-bellied Crested Babbler	8	12	20	23
Black-naped Blue Flycatcher	1	17	18	24
Lesser Graybird	2	13	15	25

at Mile 13 and Mile 22 separately because of the differences in study methods, however hill flocks or waves may include all of the variables indicated and may even include the species differential as noted at Subang. Other observers have ascribed importance in flock associations to call, color, and feeding habits. These are touched upon in the present studies without conclusions since the tropical forest habitat does not lend itself to ready experimentation for conclusive evidence about such a complex of relationships as exists in these flocks.

COMPOSITION OF FLOCKS AT MILE 13

During 23 months (Jan 1959–Dec 1960) 74 observations were made along the logging trail. A total of 74 waves were intercepted, and 89

species and 2983 individuals were recorded. The average number of birds counted per wave was 34, species seen was 7.6, and number of birds per species 2.7. None of these figures can be considered more than averages from the field observations because the terrain, vegetation, and depth of the waves made accurate and full accounting of the participants impossible for one observer.

Table 2 lists the data by month concerning these observations. During the period April through September, 17 waves were noted while 57 were seen in the remaining six months. A breakdown by families of the 89 species represented in the flocks is given in Table 1. Dicrurids were represented in 47% of the flocks, campephagids in 71%, pycnonotids in 51%, aegithinids in 89%, timaliids in 54%, muscicapids in 54%, and sylviiids in 47%. No one species was seen in every feeding flock. This may have been the result of an actual difference in the composition of some flocks or the observer may have overlooked them. Because of the prominence of campephagids and aegithinids in these flocks they should be designated as Minivet-Leafbird Waves.

Nine species appeared in more than 25% of the flocks: Yellow-headed Green Leafbird, Fiery Minivet, Scarlet Minivet, Common Nun Babbler, Racquet-tailed Drongo, Black-headed Oriole, Arctic Leaf Warbler, Paradise Flycatcher, and Fairy Bluebird. Twenty species appeared in 12% or more of the flocks and 60 additional species were seen occasionally. Table 3 lists the species noted regularly in the waves at Miles 13 and 22. Common names given follow McClure (1963).

By tallying individuals away from feeding flocks, Moynihan (1962) and Davis (1946) attempted to determine if certain species tended to join flocks more than others. Similar observations were made at Mile 13 which was a linear tally area permitting the observer to see birds unrelated to flocks as well as with them. The numbers tallied are compared for 36 species in Table 4. Several of the species listed in Table 4 as "Regular Attendants" to feeding flocks at Mile 13, where the habitat had been disturbed by timber cutting, were much more closely associated with waves at Mile 22, where the canopy was unbroken. In the undisturbed forest the Scarlet and Fiery minivets, Lesser, Greater and Yellow-headed Green leafbirds, Common Nun Babblers, Spotted Fantail Flycatchers and Flyeaters are probably rarely seen away from flocks.

The interspecific contacts within mixed species flocks were many, such contacts (by sight, sound, and touch) increasing by the square of the numbers of individuals involved. The species moved among each other, competed for food, stole food from their own and other species, touched each other, heard the calls of each species, and saw the colors of each species, their patterns of flight and other movements.

TABLE 4
SPECIES APPEARING IN MIXED FLOCKS AT MILE 13 AND THEIR NUMERICAL RELATIONSHIP
TO THOSE NOTED AWAY FROM MIXED SPECIES

	No. of flocks	Ave. per flock	Total birds seen	
			in flocks	outside flocks
<i>70 to 100% tallied in mixed flocks</i> —Habitual attendants				
White-bellied Crested Babbler	8	7.2	58	2
Arctic Leaf Warbler	26	5.4	141	19
<i>40 to 69% tallied in mixed flocks</i> —Usual attendants				
Chestnut-breasted Malcoha	16	1.7	27	37
Grey-and-buff Woodpecker	7	1.6	11	11
Crow-billed Drongo	11	1.4	15	20
Black-winged Flycatcher-shrike	13	1.4	18	16
Bar-winged Flycatcher-shrike	16	2.1	34	19
Ashy Minivet	8	4.5	36	31
Hairy-backed Bulbul	8	3.5	28	41
Green Iora	15	2.8	42	26
Chestnut-backed Scimitar Babbler	5	1.4	7	4
Paradise Flycatcher	21	1.6	33	20
Velvet-fronted Nuthatch	8	1.7	14	8
<i>10 to 39% tallied in mixed flocks</i> —Regular attendants				
Raffles Malcoha	9	1.1	10	17
Red-rumped Trogon	16	1.7	27	37
Crimson-winged Woodpecker	8	1.4	11	20
Black-headed Oriole	27	1.8	48	102
Large Racquet-tailed Drongo	29	2.0	58	414
Fiery and Scarlet Minivets	45	5.4	242	492
Red-eyed Brown Bulbul	11	2.6	29	135
White-throated Bulbul	5	2.8	14	38
Lesser Green Leafbird	13	4.1	53	90
Greater Green Leafbird	5	2.8	14	45
Yellow-headed Green Leafbird	52	4.8	252	468
Fairy Bluebird	19	2.4	46	228
Lesser Red-headed Tree Babbler	8	3.7	30	85
Common Nun Babbler	30	7.1	215	420
Spotted Fantail Flycatcher	9	1.9	17	30
Grey-headed Flycatcher	13	2.2	29	194
Verditer Flycatcher	5	1.4	7	18
Flyeater	7	2.1	15	114
Sultan Tit	5	1.4	7	21
Orange-bellied Flowerpecker	5	2.8	14	34
<i>1 to 9% tallied in mixed flocks</i> —Accidental attendants				
Streaked Bulbul	5	1.6	8	108
Little Spiderhunter	10	1.9	19	691
Lesser Yellow-eared Spiderhunter	8	1.7	14	184

TABLE 5

THE NUMERICAL RELATIONSHIPS BETWEEN SPECIES IN FEEDING FLOCKS AT MILE 13

	1	2	3	4	5	6	7	8	9	10	11
1. Yellow-headed Green Leafbird		9	6	25	32	10	32	19	23	38	21
2. Minivets (Scarlet & Fiery)	11		7	24	32	12	37	15	34	36	14
3. Common Nun Babbler	15	13		34	51	17	50	52	43	59	16
4. Large Racquet-tailed Drongo	4	4	3		10	4	18	10	9	10	8
5. Black-headed Oriole	3	3	2	10		4	10	5	10	10	7
6. Arctic Leaf Warbler	10	8	6	24	28		34	29	19	38	12
7. Paradise Flycatcher	3	3	2	5	10	3		14	6	11	5
8. Fairy Bluebird	5	6	2	10	19	3	7		7	17	21
9. Bar-winged Flycatcher-shrike	4	3	2	11	10	5	17	14		8	6
10. Chestnut-breasted Malcoha	3	3	2	10	10	2	9	6	13		8
11. Green Iora	5	7	6	13	13	8	21	5	16	12	

To determine relationships in this table read horizontally. Example, there were 4 drongos (Line 4, col. 1) to 25 leafbirds (Line 1, col. 4) in the mixed flocks; or 6 Fairy Bluebirds (Line 8, col. 2) to 15 minivets (Line 2, col. 8).

Other observers have felt that the species in a wave were attracted to each other by color, sound, or activity and have attempted to designate these as positive or negative relationships. Moynihan (1962) classified the species as "Passive" if they moved through the forest independently and "Active" if they followed the "Passive" species. He based his conclusions on the number of times in which one species was seen "following" another. This presupposes that the act of following species by another was voluntary.

Such detailed tallying of individuals in the Gombak flocks was not attempted. Instead the numerical relationships between 11 species commonly found in Mile 13 flocks are shown in Tables 5 and 6. These multilateral tables present a three-dimensional picture which indicates that many species do seek the presence of other species even though we have no way of knowing cause and effect at this time.

FLOCK COMPOSITION AT MILE 22

From the platform the study situation was the reverse of that at Mile 13. Here the observer was stationary and the waves passed him, the view was of the top of the wave and lower levels could not be seen, movement was slower and tallying more accurate, and there was the added factor of 1000 feet higher altitude and its effect upon the species composition and abundance (for example the Large Racquet-tailed Drongo did not occur here). Such a platform could not be built at Mile 13 because lumbering was removing the giant dipterocarps.

TABLE 6

THE RELATIONSHIPS OF THE SPECIES IN FEEDING FLOCKS AT MILE 13 EXPRESSED AS
PERCENTAGES OF THE TOTAL FOR EACH SPECIES. ITALICIZED FIGURES
ARE TOTALS FOR THE SPECIES

	1	2	3	4	5	6	7	8	9	10	11
1. Yellow-headed Green Leafbird	252	75.0	46.0	42.8	44.0	45.6	36.1	27.6	22.6	34.5	24.2
2. Minivets (Scarlet & Fiery)	83.3	242	50.8	39.2	46.2	49.5	38.4	23.5	26.0	34.7	18.1
3. Common Nun Babbler	83.7	75.3	215	43.2	76.2	58.6	46.0	38.6	40.0	27.4	15.3
4. Large Racquet-tailed Drongo	74.1	68.9	46.5	58	51.7	41.3	31.0	20.6	15.5	24.1	31.0
5. Black-headed Oriole	72.9	72.9	66.6	58.3	48	45.8	29.1	33.3	33.3	25.0	18.7
6. Arctic Leaf Warbler	82.2	71.6	52.4	41.1	43.2	141	43.2	29.0	21.9	35.4	16.3
7. Paradise Flycatcher	84.8	75.7	60.6	30.3	42.4	54.5	33	33.3	24.2	33.3	30.3
8. Fairy Bluebird	78.2	80.4	34.7	28.2	65.2	30.4	17.3	46	17.3	41.3	32.6
9. Bar-winged Flycatcher- shrike	73.5	55.8	58.8	29.4	47.0	47.0	41.1	32.3	34	20.5	14.7
10. Chestnut-breasted Malcoha	85.1	85.1	37.0	51.8	48.1	48.1	37.0	40.7	33.3	27	18.5
11. Green Iora	69.0	73.8	47.6	54.7	28.5	45.2	50.0	16.6	19.0	14.2	42

To determine relationship in this table read horizontally: Example, 45.2 percent of the Green Ioras (Line 11, col. 6) were seen in association with 16.3 percent of the Arctic Leaf Warblers (Line 6, col. 11); or 66.6 percent of the Black-headed Orioles (Line 5, col. 3) with 76.2 percent of the Common Nun Babbblers (Line 3, col. 5).

During the 33 months between September 1960 and June 1963, 123 observations were made and 80 waves were recorded. The number of species noted was 75 with a total of 2911 birds. The average number of birds per wave was 32.7, average number of species per wave 9.3, and average number of birds per species 3.3 (Table 2). Among the flocks at Mile 13 many individuals were counted without being identified, but from the platform accuracy in identification and tally was much greater. Except on rare occasions every bird that passed in view was identified and counted. The flocks showed a seasonality similar to that of flocks at Mile 13. Peak activity fell in December at Mile 22 and in January at Mile 13.

The distribution among families of the 75 species seen in the flocks is shown in Table 1. Campephagids were in 94% of the waves, and aegithinids in 96%, more clearly designating the flocks as Minivet-Leafbird Associations

than the flocks at Mile 13. Muscicapids and sylviids were in 71 and 75% of the flocks respectively, and pycnonotids and timaliids 42 and 57%. Five species appeared in 50% or more of the waves. Green Iora, Scarlet Minivet, Yellow-headed Green Leafbird, Flyeater, and Bar-winged Flycatcher-shrike, in that order. An additional eleven species were in 25 to 50% of the flocks: Arctic Leaf Warbler, Spotted Fantail Flycatcher, Fiery Minivet, Common Nun Babbler, Lesser Green Leafbird, Velvet-fronted Nuthatch, Greater Green Leafbird, Fairy Bluebird, Verditer Flycatcher, Scaly-breasted Bulbul, and Grey-headed Flycatcher. The remaining 59 species were those seen in less than 25% of the flocks. Table 3 lists the common species and compares their occurrence in the waves with those of Mile 13.

At Mile 13 the length of the study route was such that birds unassociated with flocks could be counted with some assurance that they had not been counted in the flock just passed or would not be in the next flock along the way. But at the platform the Green Leafbirds, Verditer Flycatcher, Striped Tit-Babblers and others in the vicinity were probably counted and recounted during the morning as they moved about, both attendant to flocks and away from them. For this reason no attempt has been made to determine the percentage of the population of each species that was seen in flock associations.

Thirteen species habitually found in the feeding flocks are compared in Tables 7 and 8 in the same way as were species common in the Mile 13 waves. Green Ioras and Flyeaters were among the most abundant high canopy forms and occupied important positions in the guidance and cohesion of the upper levels of the waves. In 36 of the 56 flocks in which Green Ioras were present the Flyeater was also present, and in 36 of the 47 flocks with Flyeaters there were Green Ioras. The relationship between Flyeaters and Scarlet Minivets was almost the same and the three species were integral parts of the flocks. Numerically there were 13 Green Ioras to 7 Flyeaters and 12 Scarlet Minivets to 8 Flyeaters. Fairy Bluebirds filled a somewhat similar niche in the flocks at this altitude that the Racquet-tailed Drongo did lower down.

From the canopy observations there are further comparisons of the position of the Yellow-headed Green Leafbird and Common Nun Babbler in the flocks. Among the birds in 52 flocks with Yellow-headed Green Leafbirds, there were 26 with Common Nun Babblers and among 31 with the babbler there were 26 with leafbirds. Further, there were 8 babblers with each 12 leafbirds and 89.2% of the total babblers were seen in company of the leafbirds but only 58.1% of the leafbirds were with the babblers. These data from both study areas suggest that the babblers seek the company of the leafbirds.

In the upper canopy the affinity between the Green Iora, Scarlet and/or Fiery minivet, Flyeater, Barwing Flycatcher-shrike, and Spotted Fantail

TABLE 7
THE NUMERICAL RELATIONSHIPS BETWEEN SPECIES ASSOCIATED IN THE
FEEDING FLOCKS AT MILE 22, GOMBAK

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Scarlet Minivet		7	9	12	20	11	22	8	10	28	18	17	33
2. Green Iora	13		13	13	19	18	33	15	17	38	20	19	33
3. Yellow-headed Green Leafbird	11	8		12	19	13	25	11	12	25	15	16	32
4. Flyeater	8	7	8		15	12	23	11	11	24	17	14	23
5. Bar-winged Flycatcher- shrike	5	5	5	7		7	14	6	8	15	11	14	20
6. Arctic Leaf Warbler	9	5	7	8	14		22	9	7	24	14	11	30
7. Spotted Fantail Flycatcher	4	3	4	4	7	5		4	5	10	7	6	10
8. Fiery Minivet	12	6	9	9	17	11	24		12	30	15	21	32
9. Common Nun Babbler	10	6	8	9	12	14	20	8		23	16	16	23
10. Velvet-fronted Nuthatch	3	3	4	4	7	4	10	3	4		8	6	11
11. Lesser Green Leafbird	5	5	6	6	8	7	14	6	6	13		10	18
12. Greater Green Leafbird	6	5	6	7	7	9	17	5	6	17	10		13
13. Fairy Bluebird	3	3	3	4	5	3	10	3	4	9	5	7	

To determine relationships in this table read horizontally: Example, 19 Green Iora (Line 2, col. 5) were found in association with 5 Bar-winged Flycatcher-shrike (Line 5, col. 2).

Flycatcher appeared to be very strong. All five of them were present in 11 (13.7%) of the waves, four of them in any combination were present in 21 (26.2%), and three of them in 28 (35%) of the flocks. Two species were present in 12 (15%) waves, six waves had but one species, and only two flocks were free of them.

Separated by only nine miles of continuous forest and 1000 feet altitude on the same watershed, the flocks of both study areas can probably be considered components of wave action that is relatively similar all along the range to about 3000 feet. Combining the data from 154 waves probably arranges the species in order of occurrence which would be generally true for the whole watershed (Table 3). Since the top and bottom of such waves could not be seen at the same time, the number of birds involved in the waves may lie somewhere near the combined total of the two areas, i.e., 70 individuals of 17 species.

OTHER FLOCKS WITHIN THE CANOPY

Winterbottom (1943, 1949), Moynihan (1962), and others noted that there were other flocks within the canopy which were unrelated to the feeding flocks of predominantly insectivorous species but which were often in-

TABLE 8

THE TOTAL BIRDS FOUND IN FEEDING FLOCKS AT MILE 22 AND PERCENTAGE OF
THESE BIRDS FOUND IN ASSOCIATION WITH OTHER SPECIES

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Green Iora	345	79.7	62.0	65.7	59.1	64.3	57.9	50.7	37.9	40.5	62.8	36.8	43.4
2. Yellow-headed Green Leafbird	80.7	270	71.8	61.8	55.5	49.6	58.1	42.9	32.2	35.1	56.6	39.2	34.0
3. Scarlet Minivet	63.4	71.5	257	66.1	56.0	31.5	47.4	66.3	52.9	39.2	48.2	43.1	43.1
4. Flyeater	83.5	69.0	71.5	200	65.0	50.5	50.5	68.0	51.0	37.0	64.5	48.0	45.5
5. Arctic Leaf Warbler	69.3	69.3	77.9	63.0	163	61.3	46.6	66.8	55.2	39.8	64.4	50.9	41.7
6. Fiery Minivet	89.9	75.4	61.6	59.1	69.1	159	54.7	59.7	44.0	45.2	69.8	40.2	42.1
7. Common Nun Babbler	76.5	89.2	83.2	61.0	69.7	47.6	149	44.2	47.6	49.6	77.1	48.3	42.9
8. Bar-winged Flycatcher- Shrike	73.1	49.5	65.8	75.6	61.7	45.5	42.2	123	56.0	38.2	58.5	41.4	43.9
9. Lesser Green Leafbird	76.7	65.1	87.2	69.7	76.7	52.3	51.1	68.6	86	50.0	60.4	44.1	53.4
10. Greater Green Leafbird	83.7	68.6	69.7	60.4	67.4	39.5	54.6	39.5	52.3	86	44.1	46.5	30.2
11. Spotted Fantail Flycatcher	78.3	74.6	66.2	66.2	57.8	55.4	68.6	62.6	43.3	26.5	83	31.3	33.7
12. Fairy Bluebird	58.9	58.9	60.7	75.0	50.0	35.7	55.3	46.4	37.5	53.5	42.8	56	37.5
13. Velvet-fronted Nuthatch	73.5	67.9	73.5	69.8	52.8	41.5	52.8	67.9	67.9	28.3	50.9	43.3	53

To determine relationships in this table read horizontally. Example, 69 percent of all Flyeaters (line 4, col. 2) were found in association with 61.8 percent (line 2, col. 4) of all Yellow-headed Green Leafbirds.

corporated within them either by accident or by stimulus. In the Gombak watershed the Hook-billed Graybird moved in small flocks and in directions that indicated no relationship to the waves, but often when they intercepted such a wave they joined it, feeding among and in association with the other flock members. Such a flock was left behind when a wave moved on or it would travel on in a route divergent to that of the wave.

At times when Brown Barbets, which normally move in flocks, were overtaken by waves the barbets moved about within the mixed flock joining in to feed, but were left behind as the wave moved on.

Also conspicuous in the canopy were barbets and bulbuls that gathered at favored fruit trees, usually figs. These trees fruited as often as three times a year and were sought out by hundreds of birds. When such a tree

was occupied by barbets and bulbuls a wave would flow through it and the insectivores would turn to the fruit as well as the insects. Such actions served to make the relationships even more complex for species as divergent in habits as minivets and barbets were now in association and at least temporarily in competition for the same food.

Although the barbet components of these frugivorous flocks, including five species, appeared to be unorganized, some of the bulbuls were in flocks. The Scaly-breasted Bulbul moved through the canopy in loose knit but organized flocks which often came in contact with the waves of insectivores, but were independent of them. They joined 22 of the 80 waves passing the platform. Their numbers exceeded those of other species of bulbuls attending the same waves. In most instances the relationship between the bulbul flock and the insectivores was only competition for the ripe fruit.

WAVES AT SUBANG

Feeding flocks did not appear to be organized as often in this swamp and lowland forest as at higher levels. Only 8 waves were intercepted, all in winter months and these included 40 species.

The White-throated Bulbul was apparently an important species in the flocks and was present in 5 of the 8. Other regularly attendant species were White-eyed Brown Bulbuls (4 of 8), Greater (3) and Lesser (3) Red-headed Tree Babblers, Raffles Malcoha (3), Chestnut-breasted Malcoha (3), Red-rumped Trogon (4), Banded Broadbill (3), Green Iora (3), Lesser Green Leafbird (3), Black-necked Tree Babbler (*Stachyris nigricollis*) (3), Paradise Flycatcher (4), and Little Spiderhunter (4).

Those species appearing twice in the flocks (25%) were: Grey-and-buff Woodpecker, Large Racquet-tailed Drongo, Crested Malay Jay (*Platylophus galericulatus*), Red-eyed Brown Bulbul, Scrub Bulbul, Plain Babbler, Red-rumped Tree Babbler, and Arctic Leaf Warbler.

Those species tallied but once in the 8 flocks were: Lesser Green-billed Malcoha, Rufous-bellied Malcoha, Blue-throated Bee-eater, Banded Red Woodpecker, Orange-backed Woodpecker, Green Broadbill (*Calypomena viridis*), Black-crested Magpie (*Platysmus leucopterus*), Ashy Minivet, Fiery Minivet, Crested Brown Bulbul (*Pycnonotus eutilotus*), Greater Green Leafbird, Yellow-headed Green Leafbird, Ferruginous Babbler (*Trichastoma bicolor*), Black-naped Blue Flycatcher, Crimson-breasted Flowerpecker, Scarlet-backed Flowerpecker (*Dicaeum cruentatum*), and Purple-naped Sunbird.

These lowland flocks were characterized by more bulbul and babbler participants than the mountain flocks. Both groups were active "organizers" filling the niches of the leafbirds and ioras in Gombak. Since this forest had only two stories and the trees lacked the height of those of Gombak, the canopy species were less involved or lacking. They were proportionately fewer in the whole population. This was a habitat of babblers and bulbuls and they dominated the feeding flocks as well.

In spite of differences in composition the average wave as recorded in all three study areas was remarkably uniform. About the same number of species, birds, and birds per species were involved in flocks in each location (Table 9).

FLOCK PARTICIPANT CLASSIFICATION

Moynihan (1962) revised earlier concepts and set up categories to indicate degrees of importance or effect in the flocks. Those species that the flocks appeared to be built around and which through voice, color, and action seemed to mold or hold the flock he designated as *nuclear*. Others were *attendant*. Species usually present were *regular*, less often seen *occasional*. Leaders which did not approach or follow other species so often were *passive* and species that followed others were *active*. This classification applies to the abundant or common forms in waves and does not attempt to include those species that are excited by a wave's passage and join it for a short distance or those that are incorporated only as the wave flows over. These could be designated as *temporary attendants* and *accidental attendants*.

The twenty ranking Gombak species based upon the numbers of waves in which they were known to occur were as follows:

Rank	Species	Moynihan's Classification
1	Yellow-headed Green Leafbird	Regular-passive-nuclear
2	Green Iora	" " "
3	Scarlet Minivet	" " "
4	Arctic Leaf Warbler	" active "
5	Fiery Minivet	" passive "
6	Common Nun Babbler	" " "
7	Barwinged Flycatcher-shrike	" active attendant
8	Flyeater	" " nuclear
9	Spotted Fantail Flycatcher	" " attendant
10	Fairy Bluebird	Occasional-active-attendant
11	Lesser Green Leafbird	" " nuclear
12	Velvet-fronted Nuthatch	" " attendant
13	Paradise Flycatcher	" " "
14	Large Racquet-tailed Drongo	Regular-passive-attendant
15	Greater Green Leafbird	Occasional-active-nuclear
16	Black-headed Oriole	Occasional-passive-attendant
17	Verditer Flycatcher	" active "
18	Scaly-breasted Bulbul	" passive "
19	White-bellied Crested Babbler	" active nuclear
20	Chestnut-breasted Malcoha	" " attendant

TABLE 9
A COMPARISON OF THE AVERAGE FEEDING FLOCK RECORDS FROM
THE THREE STUDY AREAS NEAR KUALA LUMPUR

Altitude	Subang 150 ft	Gombak Mile 13 500-1,000 ft	Gombak Mile 22 2,000 ft
Number of flocks	8	74	80
Total species	40	88	75
Average number of species per flock	11.0	7.6	9.8
Total birds	227	2,983	3,045
Average number of birds per flock	28.3	34.2	37.0
Average number of birds per species per flock	2.6	2.7	3.3

GENERAL OBSERVATIONS

The flocks appeared to arise spontaneously. The abundant, gregarious Common Nun Babbler was usually involved in the Gombak waves and its insistent five-to-seven-noted flock call of descending inflection was usually evidence that a wave was approaching. From the platform this call could be heard before any birds approached, but there was no evident movement of birds toward the sound to indicate that the calls were an assembly note. Along the Mile 13 route these babblers were often at the head of a wave.

From the platform the calls were often heard at dawn, but it would be an hour or so before wave leaders would appear. This early morning period may have been taken up in preening and indiscriminate feeding. What set a wave in motion was never evident.

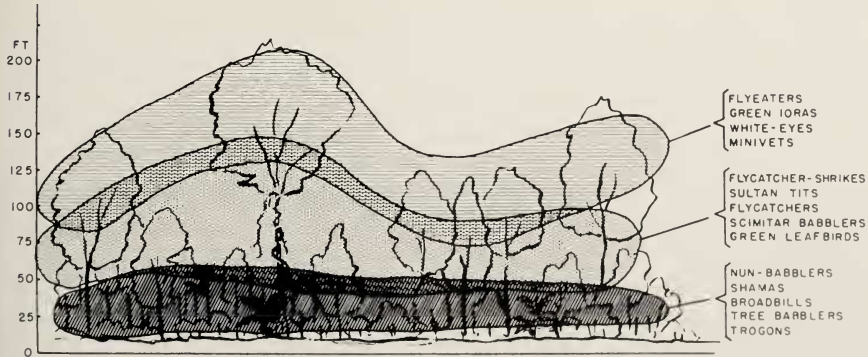


FIG. 4. The usual realms of bird groups within a wave.

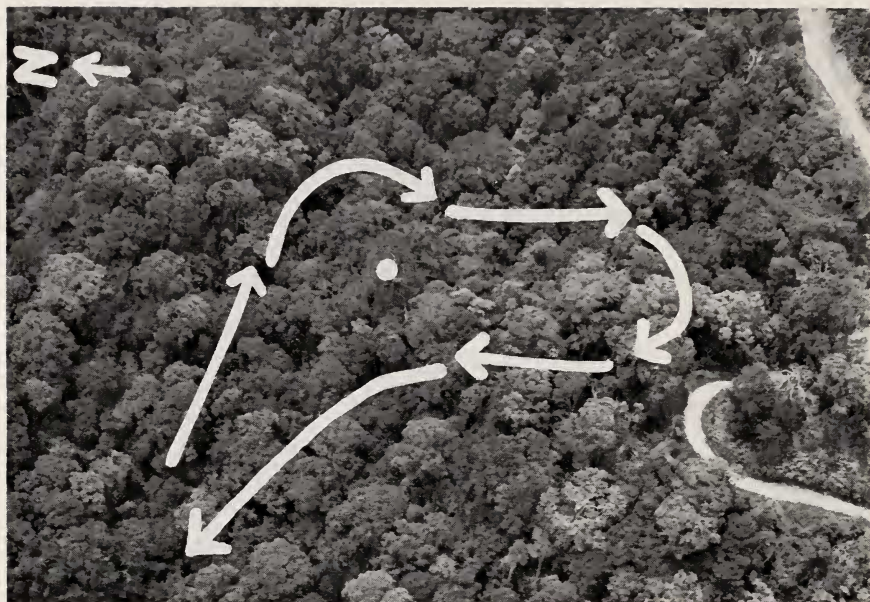


FIG. 5. Usual route of the mixed flock that fed in the vicinity of the platform at Mile 22.

When moving through the forest a wave had length, breadth and depth. At times the babblers would lead or they might be overrun by the flycatchers, cuckoo-shrikes and minivets above them, and at other times pseudopodia of species would stream ahead at different levels.

The wave filled the forest and its depth was controlled by the height of the trees. It was usually not much wider than high but had considerable length, up to a thousand feet attenuating to the malcohas and trogons at the tail.

There was some vertical movement of species within the wave, but in general species or groups of species tended to stay at relatively uniform heights (Fig. 4). An individual such as a Paradise Flycatcher might spiral down after a falling insect but would usually return to the same general level at which the group was feeding.

The speed at which a wave moved forward was often great enough that counting and identification of individuals became difficult. It usually took several minutes for all to move on and the last malcoha to arrive. At the height of the platform the motion was slower so that the lower levels of birds were usually ahead of the ioras or minivets which would work slowly through a crown and then catch up by dashing to the next crown.

It was noticed that along the Mile 13 route certain areas of the forest were

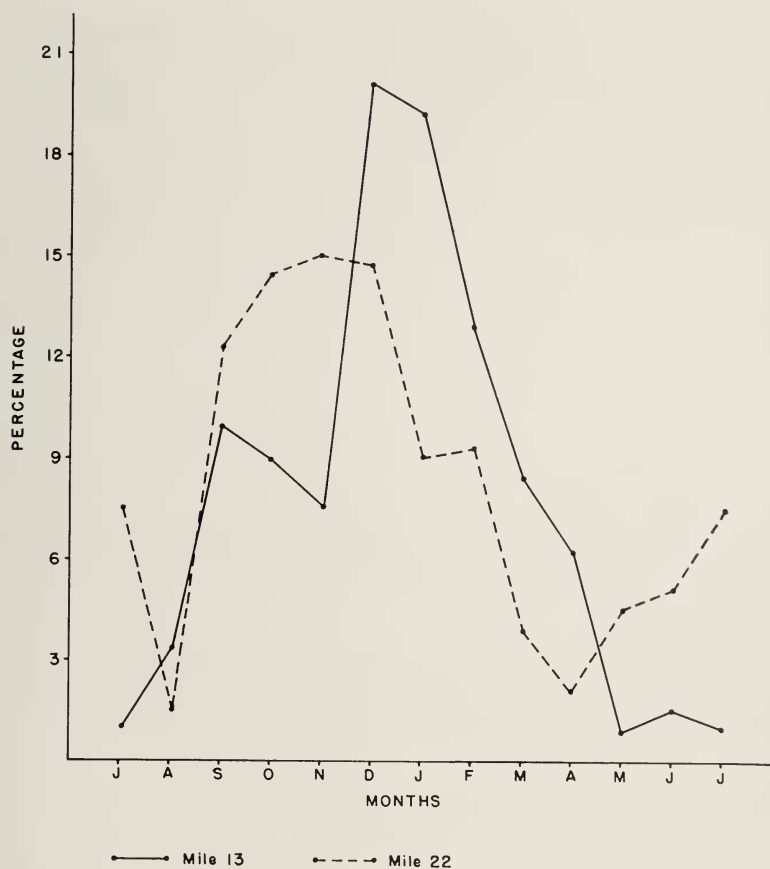


FIG. 6. The seasonality of flock formation, based upon the percentage of field observations when waves were intercepted at Mile 13 and Mile 22 of the Gombak watershed.

usual flight paths of the waves. At the platform the restricted areas used by waves became more evident. Here the usual route was that shown in Fig. 5. Occasionally a wave would come from the south above the tree and return to the valley. On these occasions it was assumed that the wave had passed up the hillside at a distance too great from the tree to be seen and was returning through the tree. The pattern shown in Fig. 5 was so persistent that it was obviously the territory and route of one flock. When a male Chestnut-backed Scimitar Babbler moved into the area and attended the flock regularly, it served to support this assumption since it was an identifiable individual.

The routes followed by certain species were characteristic. The trogon

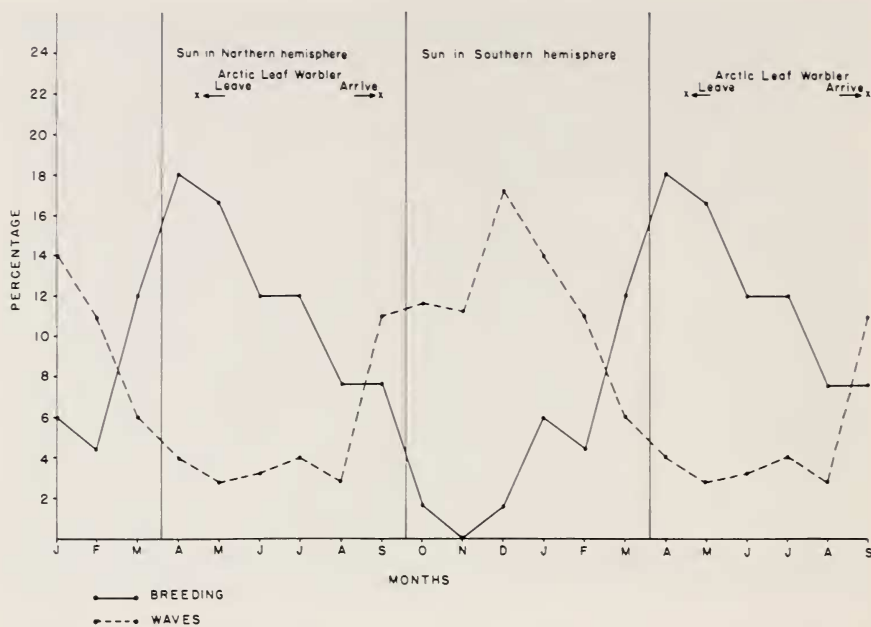


FIG. 7. The relationship between the number of feeding flocks seen each month and the amount of breeding in the population as indicated by the percentage of the total flocks seen and the percentage of the annual breeding activities noted.

tends to sit quietly on a low branch while the flock passes by and then to fly on just before the malcoha arrives. Nuthatches searched the trees as nuthatches do everywhere. Among steep hillsides and valleys the patterns were often somewhat different. The bulk of the wave followed contours while certain species made shortcuts across valleys between large trees. Although tree swifts were never an integral part of such waves they occasionally worked above them as if gleaning insects that became airborne to escape the feeding flock.

From the platform it was noted that birds took similar routes often enough to suggest that one individual was involved.

Following or during their morning flight, flocks were observed to bed down and rest or preen. Many species drifted away (malcohas or woodpeckers) but the flycatchers, babblers, flycatcher-shrikes, leafbirds, and others of the middle canopy descended into a dense tree or clump. The minivets often rested on some high limb, but not necessarily near or above the lower canopy forms. The wave poured into its roost with the same speed at which it moved while feeding. How long the flock remained quiet was prob-

ably dependent upon many things, but if startled the whole troupe streamed from its roost and moved away.

A flock usually had about 10 species that included most of the birds, but as has been discussed, other species were incorporated as the wave passed. Mammals, especially squirrels, were also stimulated by the presence of a wave. Three species—*Callosciurus tenuis*, *C. nigrovittatus*, and *C. vittatus*—were often seen in association with the birds. These came out of hiding and scurried through the trees in which the birds were feeding. They also fed upon bark, fruit, and buds and then returned to their hiding places after the flock had passed.

Where, how, when, and if the flock disbands in the evening for sleep was not determined.

Although seasonality in the temperate zone sense with its overt and massive phenological events is unknown in the tropical rain forest at 3° north of the equator, there were regular phenological determinants which could trigger physiological responses in local residents. These included arrival and departure of migrants from the north, the change in the position of the sun from north to south of zenith and return, and the regular January–February dry period brought on by the change in monsoon winds and the resulting defoliation and fruiting of some forest tree species during this period. The formation of the feeding flocks was seasonal. An occasional flock may be assembled during any month of the year, but they were regularly seen from August into April, with peak numbers from October into February. Figure 6 illustrates by month the percentage of the field observations when waves were identified. This period of intensive flocking coincides with the presence of such migrants as the Arctic Leaf Warbler which were attendant to many of the flocks. Not only were there more waves during the winter months, but also the number of birds per flock was greatest (Table 2).

Evidence of breeding (feeding fledglings, building nests, carrying food to nestlings) was recorded for 36 species and peak activity came between March and June in this watershed and at this altitude. In coastal lowland habitats it was two months earlier. Figure 7 compares the amount of breeding based on the percentages of the annual observations of breeding activities seen each month with the amount of flocking. In this watershed the grouping into feeding flocks coincided with a reduction of breeding activities of local birds, with the presence of northern migrants, and with the presence of the sun in the southern hemisphere.

APPENDIX

List of species of birds associated with feeding flocks in the Gombak watershed. Those found in more than 50 per cent of the flocks indicated by 1; 25 to 49 per cent by 2; 12 to 24 per cent by 3; and 1 to 11 per cent by 4.

Columbidae: Lesser Thick-billed Green Pigeon (*Treron curvirostra*), 4.

Psittacidae: Blue-crowned Hanging Parakeet (*Loriculus galgulus*), 4.

Cuculidae: Chestnut-breasted Malcoha (*Phaenicophaeus curvirostris*), 3; Raffles Malcoha (*P. chlorophaeus*), 4; Red-billed Malcoha (*P. javanicus*), 4; Lesser Green-billed Malcoha (*P. diardi*), 4; Rufous-bellied Malcoha (*P. sumatranus*), 4; Drongo-Cuckoo (*Surniculus lugubris*), 4; Violet Cuckoo (*Chalcites xanthorhynchus*), 4; Emerald Cuckoo (*C. maculatus*), 4.

Trogonidae: Red-rumped Trogon (*Harpactes duvauceli*), 4.

Meropidae: Blue-throated Bee-eater (*Merops viridis*), 4; Red-bearded Bee-eater (*Nyctiornis amictus*), 4.

Capitonidae: Little Barbet (*Megalaima australis*), 3; Gold-whiskered Barbet (*M. chrysopogon*), 4; Yellow-crowned Barbet (*M. henrici*), 4; Gaudy Barbet (*M. mystacophanes*), 4; Brown Barbet (*Calorhamphus fuliginosus*), 3.

Picidae: Fulvous-rumped Woodpecker (*Meiglyptes tristis*), 3; Crimson-winged Woodpecker (*Picus puniceus*), 4; Banded Red Woodpecker (*P. miniaceus*), 4; Checker-throated Woodpecker (*P. mentalis*), 4; Grey-and-buff Woodpecker (*Hemicircus concretus*), 4; Maroon Woodpecker (*Blythipicus rubiginosus*), 4; Great Slaty Woodpecker (*Mulleripicus pulverulentus*), 4; Orange-backed Woodpecker (*Chrysocolaptes validus*), 4.

Eurylaimidae: Black-and-red Broadbill (*Eurylaimus ochromalus*), 4; Banded Broadbill (*E. javanicus*), 4.

Laniidae: Brown Shrike (*Lanius cristatus*), 4.

Oriolidae: Malaysian Black-headed Oriole (*Oriolus xanthonotus*), 2.

Dicruridae: Large Racquet-tailed Drongo (*Dicrurus paradiseus*), 2; Crow-billed Drongo (*D. annectans*), 3.

Campephagidae: Scarlet Minivet (*Pericrocotus flammeus*), 1; Fiery Minivet (*P. igneus*), 2; Ashy Minivet (*P. divaricatus*), 4; Bar-winged Flycatcher-shrike (*Hemipus picatus*), 1; Black-winged Flycatcher-shrike (*H. hirundinaceus*), 3; Lesser Graybird (*Coracina fimbriata*), 3; Hook-billed Graybird (*Tephrodornis gularis*), 4.

Pycnonotidae: Scaly-breasted Bulbul (*Pycnonotus squamatus*), 2; Red-eyed Brown Bulbul (*P. brunneus*), 3; Grey-bellied Bulbul (*P. cyaniventris*), 4; Stripe-throated Bulbul (*P. finlaysoni*), 4; White-eyed Brown Bulbul (*P. simplex*), 4; Black-headed Bulbul (*P. atriceps*), 4; Black-crested Yellow Bulbul (*P. dispar*), 4; Black-and-white Bulbul (*P. melanoleucos*), 4; Lesser Brown Bulbul (*P. erythrophthalmos*), 4; Ashy Bulbul (*Hypsipetes flavalis*), 3; Streaked Bulbul (*H. viridescens*), 3; Hairy-backed Bulbul (*H. criniger*), 4; Crested Olive Bulbul (*H. charlottae*), 4; White-throated Bulbul (*Criniger phaeocephalus*), 4; Scrub Bulbul (*C. bres*), 4; Finsch's Bulbul (*C. finschi*), 4.

Aegithinidae: Yellow-headed Green Leafbird (*Chloropsis cochinchinensis*), 1; Lesser Green Leafbird (*C. cyanopogon*), 2; Greater Green Leafbird (*C. sonnerati*), 2; Green Iora (*Aegithina viridissima*), 1; Great Iora (*A. lafresnayei*), 4; Fairy Bluebird (*Irena puella*), 2.

Timaliidae: Common Nun Babbler (*Alcippe poiocephala*), 2; Striped Tit Babbler (*Macronus gularis*), 3; Chestnut-backed Scimitar Babbler (*Pomatorhinus montanus*), 3; White-bellied Crested Babbler (*Yuhina zantholeuca*), 3; Lesser Red-headed Tree Babbler (*Malacopteron cinereum*), 4; Greater Red-headed Tree Babbler (*M. magnum*), 4; Plain Babbler (*M. affine*), 4; Red-rumped Tree Babbler (*Stachyris maculata*), 4.

Muscicapidae: Spotted Fantail Flycatcher (*Rhipidura perlata*), 2; Verditer Flycatcher (*Muscicapa thalassina*), 2; Grey-headed Flycatcher (*Culicicapa ceylonensis*), 2; Paradise Flycatcher (*Terpsiphone paradisi*), 2; Black-naped Blue Flycatcher (*Hy-*

pothymis azurea), 3; Tickell's Blue Flycatcher (*Muscicapa tickelliae*), 4; Brown Flycatcher (*M. latirostris*), 4; Siberian Flycatcher (*M. sibirica*), 4; Chestnut-winged Flycatcher (*Philentoma pyrrhoptera*), 4.

Sylviidae: Flyeater (*Gerygone fusca*), 1; Arctic Leaf Warbler (*Phylloscopus borealis*), 2; Lesser Brown Wren-Warbler (*Prinia rufescens*), 4; Black-necked Tailorbird (*Orthotomus atrogularis*), 4.

Turdidae: Common Shama (*Copsychus malabaricus*), 4.

Paridae: Sultan Tit (*Melanochlora sultanea*), 4.

Sittidae: Velvet-fronted Nuthatch (*Sitta frontalis*), 2.

Zosteropidae: Oriental White-eye (*Zosterops palpebrosa*), 4.

Dicaeidae: Orange-bellied Flowerpecker (*Dicaeum trigonostigma*), 4; Crimson-breasted Flowerpecker (*Prionochilus percussus*), 4; Yellow-throated Flowerpecker (*P. maculatus*), 4; Thick-billed Flowerpecker (*D. agile*), 4; Plain Flowerpecker (*D. concolor*), 4.

Nectariniidae: Little Spiderhunter (*Arachnothera longirostris*), 3; Lesser Yellow-eared Spiderhunter (*A. chrysogenys*), 4; Long-billed Spiderhunter (*A. robusta*), 4; Grey-breasted Spiderhunter (*A. affinis*), 4; Scarlet Sunbird (*Aethopyga mystacalis*), 4; Yellow-backed Sunbird (*A. siparaja*), 4; Ruby-cheeked Sunbird (*Anthreptes singalensis*), 4; Rufous-throated Sunbird (*A. rhodolaema*), 4; Purple-naped Sunbird (*Nectarinia hypogrammica*), 4.

Ploceidae: Sharp-tailed Munia (*Lonchura striata*), 4.

SUMMARY

Between January 1959 and June 1963 feeding flocks (bird waves) of mixed species of insectivores were under observation in Central West Malaya, 8 in a secondary forest at 150 feet altitude, 74 in lowland forest at 1,000 feet, and 80 in sub-montane forest at 2,000 feet. One hundred nine species were in association in these flocks, of which 20 were the most often encountered as nuclear or regularly attendant species. Five species of aegithinids, *Aegithina viridissima*, *Chloropsis cochinchinensis*, *C. sonnerati*, *C. cyanopogon*, *Irena puella*, and two campephagids *Pericrocotus igneus* and *P. flammeus* dominated the flocks. The timaliid *Alcippe poiocephalus* and sylviid *Gerygone fusca* were important wave "organizers" having conspicuous flock calls.

The segments of waves recorded usually included about 10 species and 35 individuals, but much greater numbers were encountered. The average number of individuals per species varied with the species and season. Greatest number of waves, species and individuals were encountered between November and March. Waves flowed through the forest in definite patterns and had length, depth, and width. The species in the flocks tended to remain at certain levels within the canopy and position within the wave.

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NEW LIFE MEMBER

A new Life member of The Wilson Ornithological Society is Arthur J. Wiseman, a registered pharmacist of Cincinnati, Ohio. Mr. Wiseman, a graduate of the University of Cincinnati, is an amateur ornithologist with a deep and serious interest in birds. His contributions to ornithology include reports to *Audubon Field Notes*, and he is currently engaged in cataloging the bird-skin collection of The University of Cincinnati. He is a member of the AOU, National Audubon Society, Inland Bird Banding Association, Northeastern Bird Banding Association, and the Cincinnati Bird Club. Mrs. Wiseman is also both a pharmacist and a dedicated amateur ornithologist.

